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Delay Actuator  
Silicone Delay

In replying please address:

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PROPOSAL FOR TIME-DELAY  
DEVICE

February 10, 1959

Dear Sir:

In accord with recent discussions with your technical representatives, we are herewith submitting a proposed program of research directed toward the development of an experimental, long-term time-delay device utilizing a silicone-type fluid.

During the past several years, a search by many organizations for a cheap, reliable, and reasonably accurate time-delay mechanism has led to the consideration of silicone fluid as a timing medium. Under Task Order No. J, basic design criteria have been established for an experimental time-delay unit which utilizes silicone fluid. The effort under this Task Order has been directed toward the development of an experimental unit for use in providing time-delay periods ranging from 15 minutes to 2 months, at temperatures varying from -20 to +120 F; the desired accuracy was such that the flow of silicone fluid could not vary more than  $\pm 10$  per cent over this range of temperatures. In the research performed under Task Order No. J, it was found necessary to incorporate in the experimental unit a device designed to provide temperature compensation, so that changes in the viscosity of the fluid that were brought about by temperature variations would not cause the flow from the experimental unit to vary beyond the specified limits.

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Processed 2/19/59

-2-

February 10, 1959

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In recent discussions, your technical representative indicated a need for another time-delay unit - one which would cause a firing pin to be activated after approximately one year had elapsed; would operate in deep water; and would be inexpensive, reliable, and relatively small. There appears to be a good possibility that some of the data obtained under Task Order No. J could be used advantageously in connection with a developmental study of a device of this kind. The deep water in which such a device would be operating under service conditions represents an environment which does not suffer major fluctuations in temperature. Consequently, it appears likely that a study directed toward the development of a suitable device using silicone fluid would not have to include consideration of means for temperature compensation, with its associated complexities. On the basis of preliminary calculations and over-all considerations, we currently feel that the development of a device of this type could be carried out satisfactorily. Described herein is a proposed program of research directed toward achieving this objective.

On the basis of discussions with your technical representative, a series of specifications has been formulated; in the proposed program, our efforts would be directed toward these as goals of the research. Thus, under service conditions in sea water at a temperature within either of two ranges, namely, 30 to 50 F, and 50 to 70 F, it would be desirable for such a device to:

- (1) Have neutral buoyancy.
- (2) Remain watertight for at least 1-1/2 years  
at a maximum depth of 200 feet.

~~CONFIDENTIAL~~

-3-

February 10, 1959

~~SECRET~~  
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- (3) Activate a firing pin reliably after a time delay of approximately 12  $\pm$  1-1/2 months.
- (4) Be self-contained, i.e., emit no silicone fluid to the ambient water.
- (5) Have outer dimensions of up to about 1-1/2 inches in diameter or maximum thickness, and a length as short as possible.
- (6) Be capable of attachment to a receptacle, the dimensions of which would be provided.

In the performance of the proposed program, it is contemplated that information developed in the research under Task Order No. J, as described above, and also under Task Order No. G would be quite applicable. The effort under Task Order No. G has been directed toward the development of experimental containers which would remain watertight during immersion in sea water for periods up to 5 years. In this research, it has been found that certain aluminum alloys can be immersed in sea water for more than 1-1/2 years without being damaged seriously; and rubber O-rings have been used successfully to seal the closures.

On the basis of data obtained under Task Order No. J, we have estimated that a tube about 10 inches long with an inside diameter of about 0.007 inch would probably serve to control satisfactorily the flow of about 1-1/2 cubic inches of Viscasil 500 for the time-delay

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~~SECRET~~

SECRET

-4-

February 10, 1959

period of interest. It appears that the force needed to extrude the fluid through the tube could be supplied by a helical, steel compression spring; and that the force could be transmitted to the fluid through a rubber Bellofram piston seal. The Bellofram and fluid chamber, and the tube could probably be incorporated into an integral unit; the tube could be coiled in order to reduce the over-all size. This integral unit could then be placed in an aluminum-alloy housing which could contain the firing mechanism and also enough volume to provide the over-all experimental device with neutral buoyancy. The design should be such that the spring could be readily insertable (as one of the last operational steps), because each of the two temperature ranges of interest would involve the use of a particular spring. Thus, in a field operation, such a device could be set for the anticipated temperature range by the operator through insertion of the proper spring.

Adequate long-term evaluation of the proposed device would require several months at a cost which is extremely difficult to estimate at this time. Consequently, it has been mutually agreed with your technical representative that the program proposed at this time should provide for effort directed toward the design, preparation, and only relatively short-term, simple, laboratory evaluation of the proposed device.

It can be seen from the above that the general configuration of what appears to be an appropriate experimental device has already been conceived. As currently contemplated, the initial effort in the proposed program would be directed toward re-considering these various

SECRET

-5-

February 10, 1959

ideas regarding specific components of the proposed device. Then, attempts would be made to combine them into a design which would reflect reliability and low cost. A design which was considered to be suitable would be laid out and discussed with your technical representative. After mutual agreement was reached, appropriate drawings would be prepared, and an experimental unit would be prepared in our laboratory.

It is currently expected that evaluation equipment set up in connection with the Task Order No. J effort could be used for the relatively short-term evaluation of the proposed experimental device. Thus, the experimental unit would be operated consecutively in constant-temperature chambers at about 35 F and 70 F for periods of a few weeks; information would be obtained regarding the extent of fluid flow under these conditions, and this would give some indication of the accuracy of the experimental device at these two temperatures. It is currently anticipated that modifications or adjustments would probably be made at least twice before results which were considered satisfactory were obtained.

Subsequently, the experimental unit and its performance would be discussed with your technical representative, including aspects of interest such as neutral buoyancy, watertightness, and release of the firing pin.

If, as expected, the results of the above-outlined research were favorable, then the advisability of performing additional appropriate research would be discussed with your technical representative. Such research would probably involve establishing the longer term performance of the experimental device. On the basis of our current

-6-

February 10, 1959

expectation, such additional research would have to be provided for under another contractual arrangement. If, on the other hand, the results were not favorable, then additional modifications and evaluation experiments would be considered and performed, within the limits of the contract funds and time provided.

During the course of the proposed research, liaison would be maintained with your technical representative by discussions during his periodic visits and via the telephone. At the conclusion of the proposed research period, a summary report would be submitted that described the experiments performed and the results obtained, and recommendations, if any, for additional research.

We propose to undertake this effort over a period of four months, starting on the date of acceptance of authorization from the Contracting Officer to proceed. The proposed investigation could be conducted under Task Order No. CC. The Work Order would be a period-basis research agreement; it could be similar in form to that used previously under Task Order No. CC and the same administrative procedure would be followed. The Work Order would require only that the research be directed toward the objective outlined above, within the limits of the time and funds provided.

It is estimated that an appropriation of \$2,999, including the fixed fee, is needed to fund the proposed program for the four-month period. A general breakdown of the estimated costs is attached.

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February 10, 1959

If any additional information is needed, please let us know.

You may direct any inquiries of a contractual nature to  
at Extension 159.

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Very truly yours,

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Vice President

EES:mlm

In Duplicate

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Proposal of  to the U. S. Government.  
For Research on the Development of a Specialized Long-Term Time-Delay Device.

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Based upon a period-basis Contract for a research period of 4 months.

(Including time for submission of all reports. The proposed contract will not provide for earlier conclusion of the research.)

### ESTIMATED COSTS

We expect that the cost of this research for the period indicated above may be distributed approximately as set forth hereon, subject to the understanding that this allocation is merely an estimate, and actual costs incurred may vary from the categories shown. We have determined that these estimates are reasonable and consistent with established policies in its research for the various Government agencies, which policies are briefly discussed below and will be followed in determination of our actual costs hereunder.

25X1

#### Materials & Supplies, etc.

\$ 80

(Including any equipment which may be purchased as necessary in performance of the research. Charges of \$25 or less are excluded from this item.)

#### Use of Equipment and Technical Services, Travel, and Misc.

\$ 325

(Including applicable costs of technical research and service divisions, and use of technical equipment, except that any undistributed balances of these accounts will be included in overhead. Cost of travel includes reasonable actual subsistence expenses and the actual cost of transportation. An allowance of up to 8¢ per mile for all necessary travel by privately owned conveyance is included in lieu of the cost of such travel.)

#### Salaries & Wages

(Including our predetermined accrual for vacation, holiday, and sick-leave pay, pensions, and social security.)

Type of Employee	No. of Man-Months	Estimated Cost
Supervision	1/5	\$205
Research Engineers	1-1/3	910
Lab. Assistants	1	400
Steno., Clerical, Shop & Photo., etc.	Nominal	Nominal
Total Salaries & Wages		

#### Overhead

\$1,515

60 per cent of salaries and wages, as they are defined above. Provisional monthly reimbursement will be at the rate of 60 per cent of salaries and wages, as so defined, or at such other provisional rate as may from time to time be mutually agreed upon with the Government's audit representatives. This is a provisional rate for current reimbursement, which we have arrived at by negotiation with Government representatives, and it will be subject to retroactive revision to the "actual" rate agreed upon with them for each calendar year following a detailed audit for that year. The item of overhead includes general research, charges of \$25 or less for materials and supplies, and other categories of costs we customarily include in our overhead account. Cash discounts on all purchases will be credited to overhead, instead of to the amount of the purchase. Scrap of appreciable value will be credited directly to the project. All other scrap will be credited to the overhead account, in which the Government participates.)

\$ 909

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Total Estimated Cost

\$2,829

Fixed Fee

\$ 170

\*Please let us have your acceptance in our hands by March 25, 1959. Contract Price  
Unless we extend the time, your acceptance after that date will be subject to agreement.

\$2,999

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